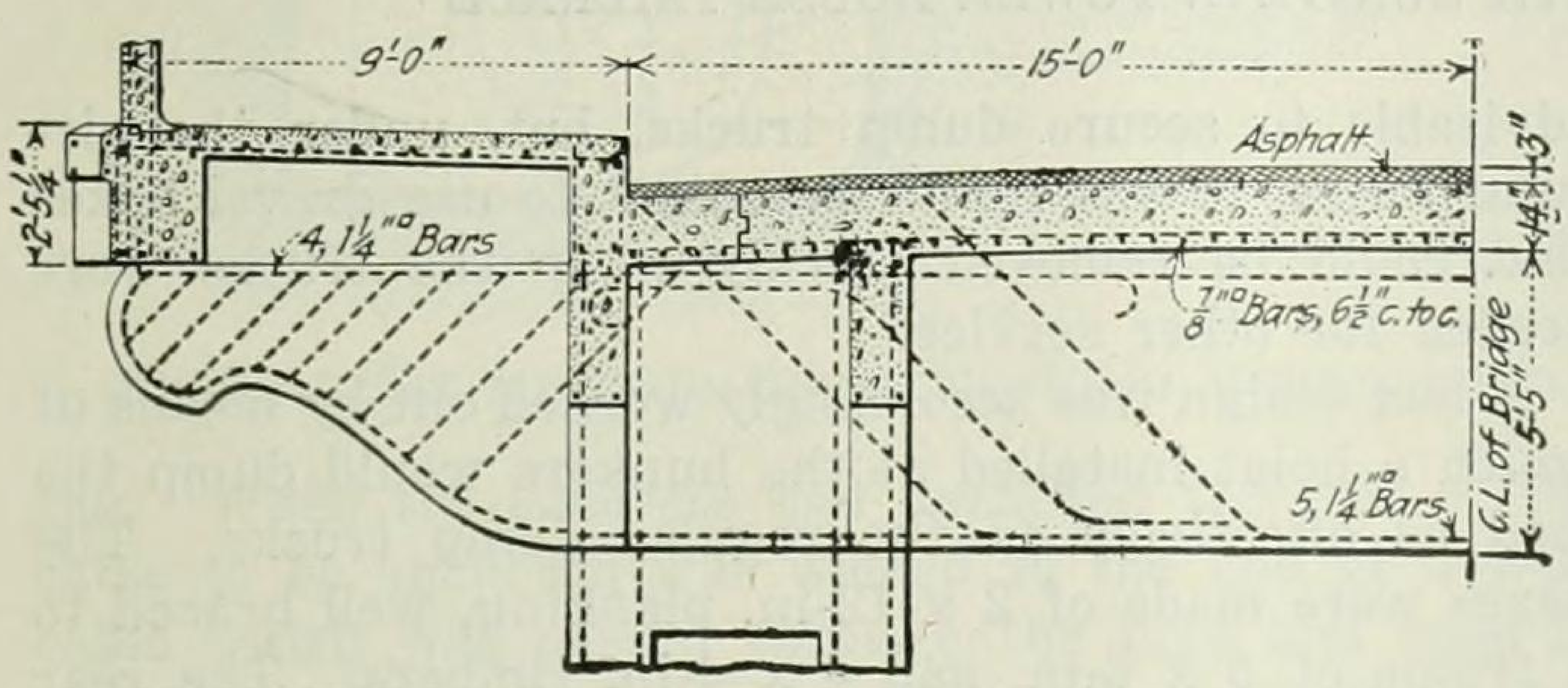
and an outline map indicating proposed highway routes in connection with the port.

The report is signed by all the members of the Port of New York Authority: For New York, Eugenius H. Outerbridge, chairman, Alfred E. Smith and Lewis H. Pounds; for New Jersey, J. Spencer Smith, chairman, De Witt van Buskirk and Frank H. Ford. W. W. Drinker is terminal engineer, E. C. Church, transportation engineer, J. A. Jackson, electrical engineer and Nelson P. Lewis, Morris R. Sherrerd and Francis Lee Stuart, members of the Technical Advisory Board. B. F. Cresson, Jr., is chief engineer and George W. Goethals, consulting engineer.

Independent Floor-Beams and Slab in New Concrete Arch Bridge

IN ORDER to simplify the floor forms in the construction of a large concrete arch bridge now being built in Pittsburgh, the engineers designed the slab and floor-beams as independent elements, the slab to rest on top of the completed floor-beams. In construction, the

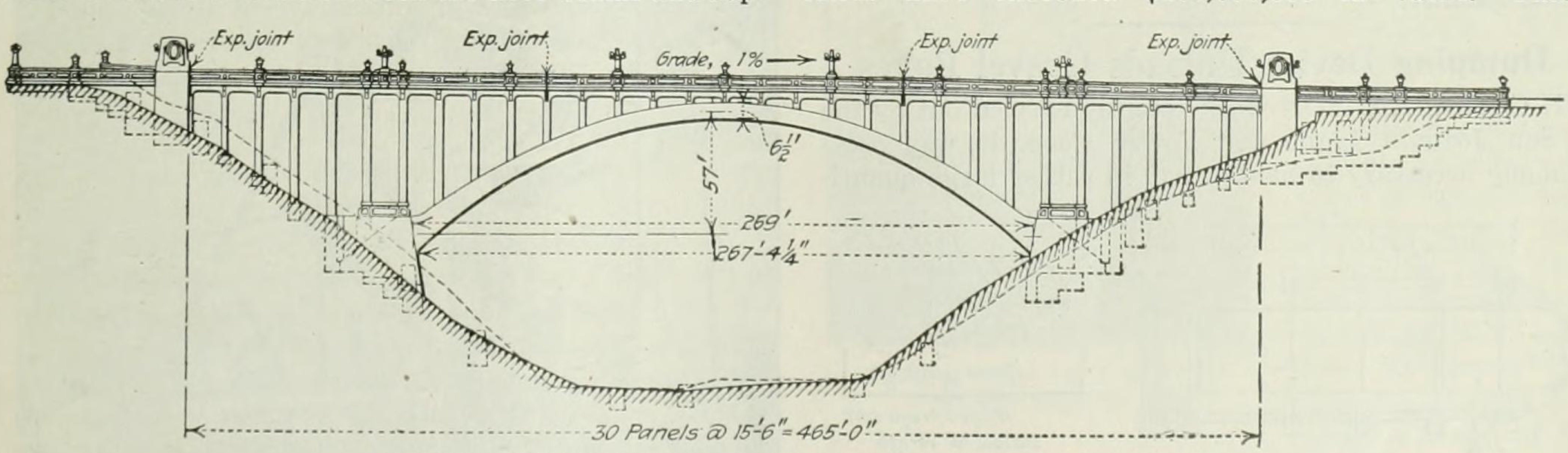


DECK CONSTRUCTION OF BEECHWOOD BLVD. BRIDGE

spandrel columns resting on the arch ribs and the floor-beams will be concreted in forms built up from the ribs and subsequently, after removal of these forms, the forms for the floor slab and the fascia stringers on either side will be built between the floor-beams and supported by them. This avoids the necessity of carrying the heavy floor forms and slab by supports extended up from the arch rib. No definite plane of separation between slab and beams is provided except that formed by the construction joint, and on the contrary the floor-beam diagonal reinforcement is allowed to extend up into the slab. But the beam is designed as though it terminated at the bottom line of the slab rather than as a beam extending to the top of the slab or as a T-beam utilizing part of the slab for compression area.

As shown in the accompanying drawing, the bridge, which is of exceptionally handsome outline, is a two-rib parabolic structure with open spandrels, of 267 ft. $4\frac{1}{4}$-in. span between faces of abutments, or 279 ft. between theoretical springing lines, and 57 ft. theoretical rise, or 55.89 ft. rise of intrados. It will carry Beechwood Boulevard across the depressed Saline St. at the entrance to Schenley Park. A sketch of the normal floor-beam construction is given in the drawing. The floor panels are $15\frac{1}{2}$ ft. long, center to center of floor-beams. The two arch ribs, 26 ft. apart on centers, are each 8 ft. wide, with a crown depth of $6\frac{1}{2}$ ft. They are reinforced with eight angles 6 x 4 x $\frac{3}{4}$ in., connected at intervals of 3 ft. by encircling tie bars $2\frac{3}{4}$ x $\frac{3}{8}$ in.

The bridge was designed by Assistant Engineer Appel of the bridge division, Department of Public Works.



GENERAL FEATURES OF BEECHWOOD BOULEVARD BRIDGE

Progress of Federal Reclamation

THE annual report of Arthur P. Davis, director of the U. S. Reclamation Service, shows that the works of the Reclamation Service in the arid and semi-arid states of the West served in the fiscal year 1920-21 areas agrgegating 2,845,000 irrigable acres, including 1,662,000 acres for which the government systems furnished the sole supply of irrigation water, and 1,183,000 acres to which in most cases the Service furnished stored water in bulk to supplement the partial supply of private systems otherwise dependent on unregulated stream flow Of the first class, 1,224,000 acres were actually irrigated and 1,154,000 harvested producing crops to the value of more than $66,000,000. Of the other class, from less complete information, it is roughly estimated that 982,000 acres were irrigated and 950,900 cropped, producing crops to the value of $47,500,000, or a grand total of nearly $114,000,000. Within the projects constructed by the Service are 32,835 irrigated farms with a total population of more than 125,000.

Since the government works began the delivery of irrigation water, the crops produced on the reclaimed lands have exceeded $400,000,000 in value. This includes nothing for the large areas under private systems served government water and does not include increased values produced as livestock and stock products. The increase in the value of lands is estimated to amount to over $500,000,000 based on government reclamation work.

At the end of the fiscal year the service had constructed 100 storage and diversion dams; more than 13,000 miles of canals, ditches and drains; 109,000 canal structures and 7,700 bridges. It had built 1,000 miles of roads, 83 miles of railroad, 4,000 miles of telephone and transmission lines and had excavated over 188,000,000 cu.yd. of earth and rock, over 9,000,000 of which was excavated in the past fiscal year.

a crushing of the bricks or a slight upward bulging, endeavor is made to prevent the more complete rupture by putting maintenance crews at work immediately, cutting the pavement at the point where the excess stress is manifest and substituting an 8-in. strip of asphaltic compound for two transverse rows of bricks. More often, however, the upheaval comes without warning and as much as 200 sq.ft. of the surface has been suddenly thrown from the base and shattered as though from an explosion. In some instances the base has been broken by the shock. In a damage suit growing out of an explosion, witnesses testified on the stand that pieces were thrown 30 to 40 ft. high in the air. Fragments are said to have been found 80 to 100 ft. from breaks.

A study of the location of the breaks does not show anything in common on this score. They occur on fills and in cuts, on the north, as well as the south slopes of hills, on the tops of gravel benches and in wet flats. On some parts of the road a number of breaks have occurred close together and in other stretches of considerable length there have been no breaks whatever. In the comparatively short section where expansion joints ½ in. wide were used in the brick, but without any joint in the concrete base, breaks occurred the same as in the other sections. In sections where new bricks have been relaid after a break, using the same form of construction as the original pavement, breaks have occurred a second time in the same spot. It is notable, however, that no breaks have recurred where the relaid pavement has been provided with the 8-in. asphaltic expansion joint referred to previously. This type of joint has now become standard practice when breaks are repaired. It extends through the concrete base as well as through the brick surfacing.

Some of the earlier failures and their possible causes were described and discussed in *Engineering News-Record*, Aug. 16, 1917, p. 319. There it was mentioned, the passing of trucks or cars over the weak spot appeared to "set off" the explosion. This fact is to be noted in connection with the accident that, as previously noted, caused legal complications.

On June 20, 1920, a truck driving over the pavement was wrecked by a violent upheaval of the surface beneath it. Such was the force that flying fragments smashed the running gear, brought the truck to a sudden stop and caused those riding on the driver's seat to be thrown to the pavement. A suit brought against King County on account of injury sustained in this accident secured a judgment from the Superior Court of King County in June, 1921, for $10,000 damages. The case was appealed to the Supreme Court of the state, which court on March 4, 1922, affirmed the judgment of the lower court. A petition for rehearing, filed by the county, is still pending.

The case did not bring out the causes of the upheaval from the engineering point of view, but rather showed that (1) the county knew the road was subject to these upheavals but (2) despite that had not succeeded in "maintaining the road in a safe and satisfactory condition" as required by statute.

Rail Earnings for August at Low Ebb

According to reports filed by the carriers with the Interstate Commerce Commission the net operating income of the Class I railroads of the United States totaled $52,579,799 in August. This represented a return of only 2.65 per cent annually on their tentative valuation.

Boldly Designed Center for Heavy Concrete Arch

Steel Viaduct Practice Applied to Timber Falsework —Settlement Under Load Less Than an Inch—No Wedges Used

A CENTERING so slender that its failure was freely predicted has recently been taken from under the successfully completed arch ribs of the Beechwood Avenue Bridge in Pittsburgh, Pa. This bridge has a clear span of 279 ft., and the two ribs with their connecting struts, which the centers had to carry, contained about 1,500 cu.yd. or, say, 3,000 tons of concrete. Four timber towers, with four legs each, carried the load during construction and the sixteen 20-in. square posts of these towers were virtually the only supports during the 2½ months while the arch ribs were being concreted. They extended upward 65 ft. unbroken by joints and there were, in fact, only four bearing surfaces from the footing to the lagging, which explains the total deflection under load of only ¾ in.

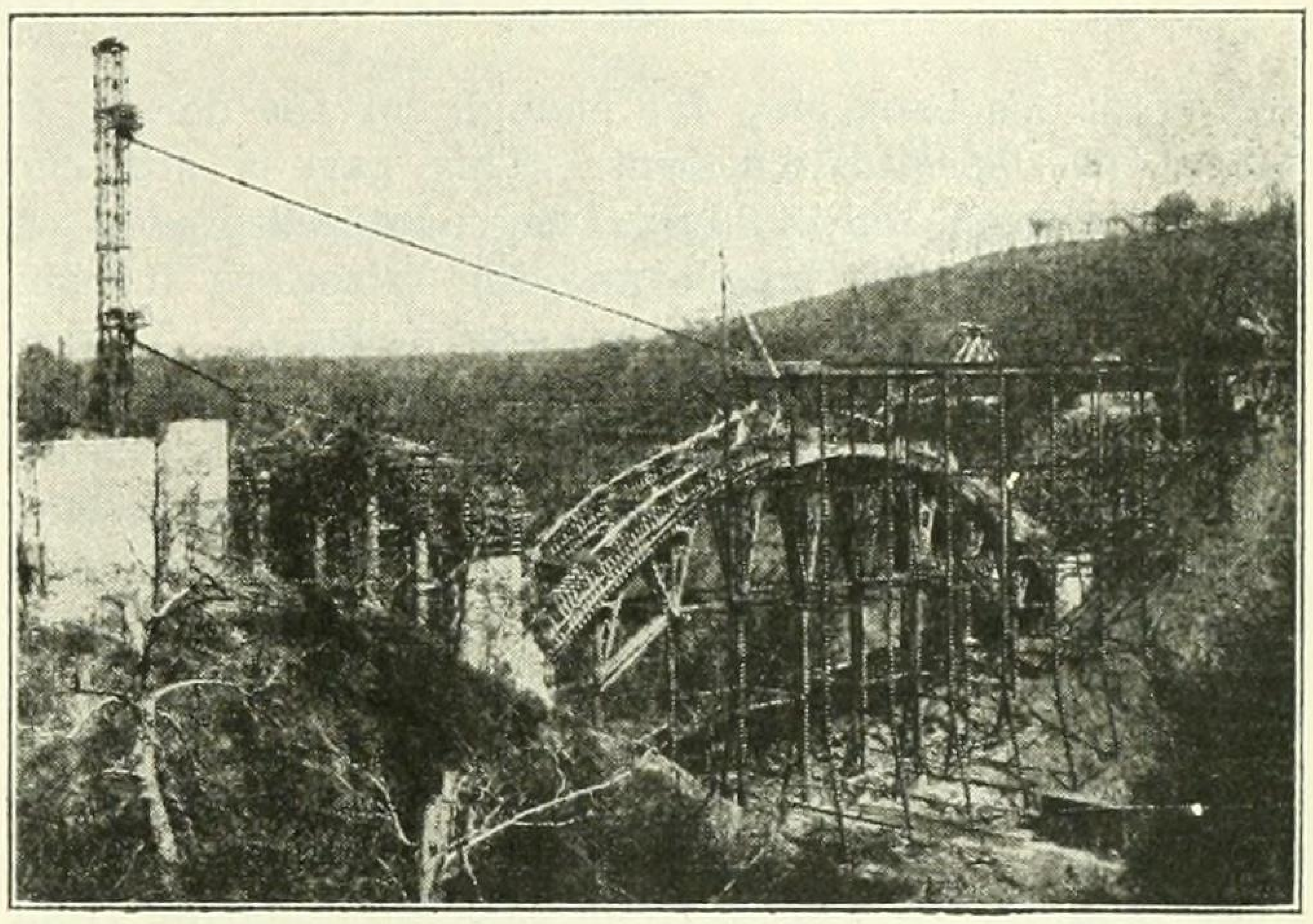


FIG. 1. CONSTRUCTION TRESTLE, CENTERING AND CHUTING PLANT

A description of the main structural characteristics of the Beechwood Avenue Bridge was published in *Engineering News-Record*, Jan. 5, 1922, p. 29, where also the principal dimensions were stated. Briefly the arch ribs are 8 ft. wide and 10 ft. deep at the springing lines tapering to 6½ ft. at the crown. The intradosal rise is 55.89 ft. Each rib is reinforced with a structural steel rib of eight 6 x 4 x ¾-in. angles and 2¾ x ⅝-in. bars. Each rib was concreted in nine sections, a crown section of 70 ft. and eight 30-ft. sections, with 3½-ft. key sections between them. Concreting the two arch ribs and eight cross struts was begun April 24 and with the exception of the key sections was completed on May 3. It took five days to ream and bolt the structural reinforcement in the key spaces and two more days to concrete the key sections, thus completing the ribs and struts on May 10.

Only two unusual features call for especial attention: (1) the trestle for the traveler which erected the centering, forms and reinforcement and (2) the falsework and centering. The view Fig. 1 shows the complete outfit, the trestle and traveler in the foreground and, behind the trestle, the falsework, centering and arch-rib forms. It will be noted that the trestle was carried

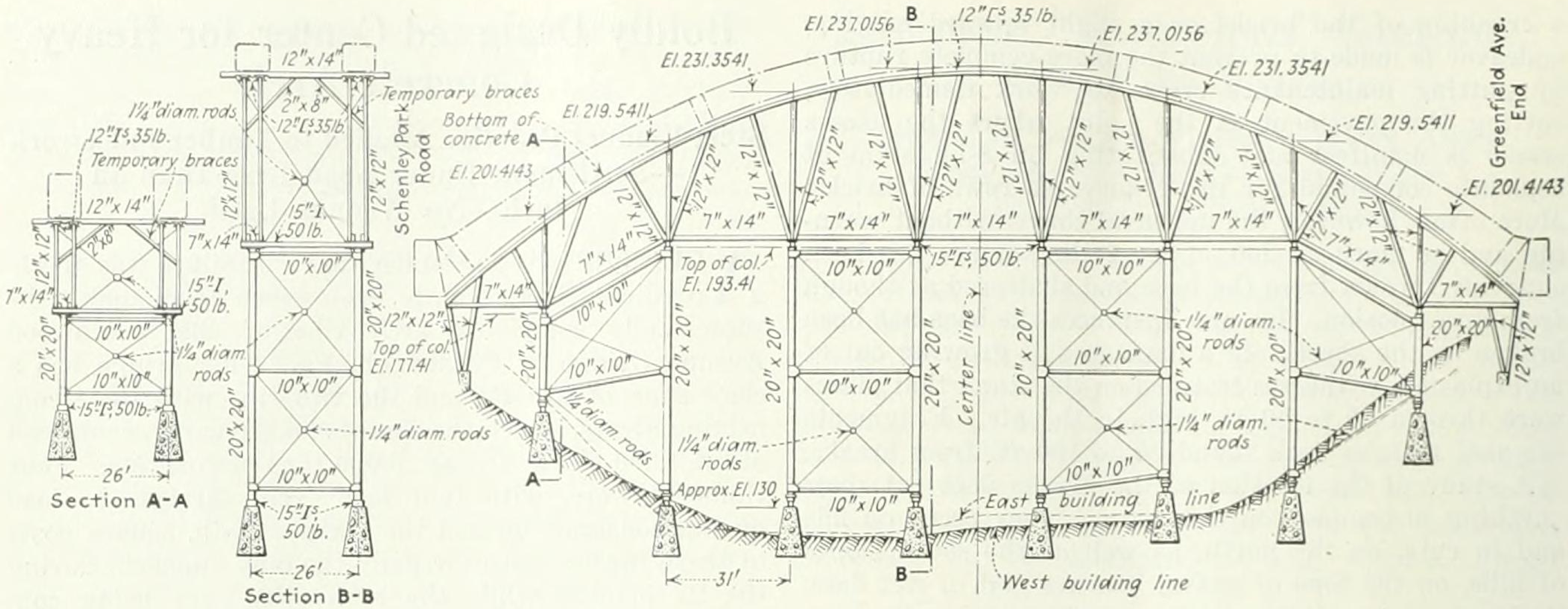


FIG. 2. FALSEWORK AND CENTERING FOR TWO-RIB ARCH

out from one bank only far enough for tne derrick to reach the opposite abutment This gave a stub-end structure about 145 ft. high at the unattached end.

In designing the trestle and the falsework for the center, steel viaduct practice was followed. Towers with four legs were braced in horizontal planes at determined intervals and in the planes of the legs with X-bracing for each vertical panel. The drawing of the falsework Fig. 2 shows the arrangement except that in the case of the trestle the legs of the bottom panel were given a transverse outward batter to widen the bases of the towers, as shown by Fig. 1.

As stated the purpose of the trestle was to erect the centers and forms and to handle the reinforcement. Practically all the concrete was placed by chuting from mixing plants located on the high banks of the gorge spanned by the arch. A 40-ton derrick traveler was planned, and to bring it well above the loads it had to handle, the top of the trestle was established at a height well above the crown of the arch ribs, as shown by Fig. 1. A uniform span of 30 ft. was adopted both between tower legs and between towers. The tower legs were made of 12 x 12-in. x 32-ft. timbers spliced together with steel plates to which the timber transverse bracing and the 1¼-in. steel-rod sway bracing were attached. The tops of the legs were capped transversely with 12 x 12-in. timbers. These caps carried a 24-in. I-beam on each side of the trestle and the traveler rails were bolted to these beams. The trestle was 33 ft. 6 in. wide on top, 375 ft. long and 145 ft. high at the highest point. There were four vertical panels in all the towers in the valley bottom while the towers on the slope had three, two and one panels as their height decreased.

Standing 145 ft. high, with its slender posts and bracing, the free end of this trestle presented an appearance of lateral instability which its action in service

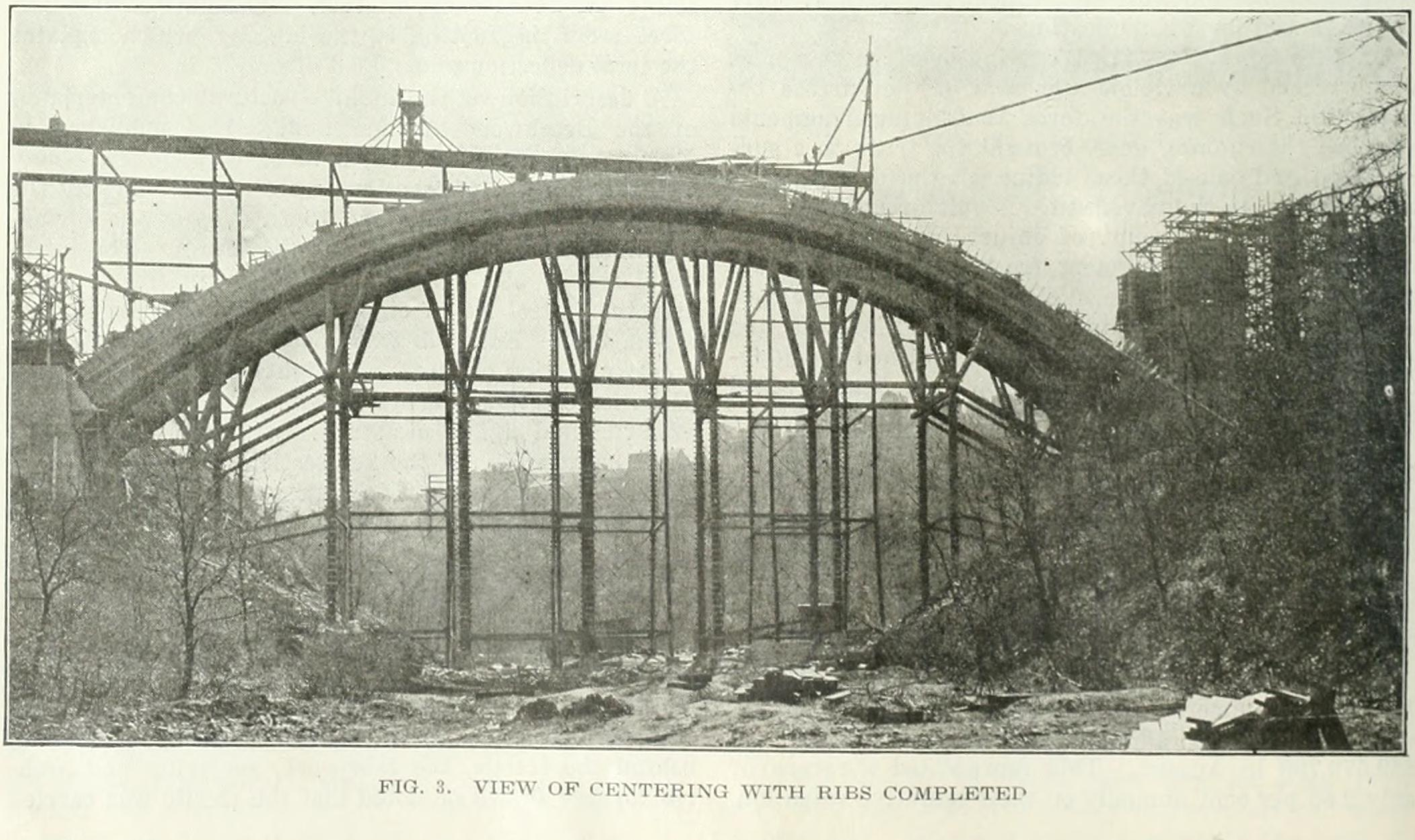


FIG. 3. VIEW OF CENTERING WITH RIBS COMPLETED

belied. With the traveler derrick swinging loads of several tons, 30 ft. or more to one side, the structure showed no appreciable side sway. In March, during several of the heaviest wind storms, with the traveler working 75 ft. from the end, transit observations showed a sway of only $\frac{1}{8}$ in. This remarkable rigidity must be attributed to the precision of the framing and erection which was virtually as great as that which would be employed in a steel structure for permanent service.

As illustrated by Fig. 2 and the views Figs. 1 and 3, the falsework for the centers consisted of four viaduct-type timber towers. Oregon fir timbers 20 in. square were used for the legs. Two short 15-in., 50-lb. I-beams were anchored to the footing pedestal and carried $\frac{3}{4}$-in. bearing plates on which the posts were seated. These posts were 63 ft. long and on their tops carried pairs of 15-in., 50-lb. I-beams. Footed on the I-beams were 12-in. square timbers, three from each post, radiating out fanwise to support segment beams which were bolted through steel stirrups capping the ends of the radial timbers. The segment beams were pairs of 12-in. 35-lb. channels bent to the curve of the arch. The remaining bracing and the essential dimensions are given by the drawing Fig. 2.

It will be noted that there are only four bearings in any line of vertical supports from the footing pedestals to the segment beams, a height of over 100 ft. As these joints were very carefully framed and assembled their compression was slight. As stated the centers settled $\frac{3}{4}$ in. when loaded and when the centers were lowered the arch ribs dropped $\frac{3}{4}$ in. more. Contemplating the old type falsework, the specifications had called for an arch camber of $3\frac{1}{2}$ in. The falsework was built to this requirement but less than half of the expected possible settlement occurred. A noticeable feature of the centering is that no wedges were used. To lower the centers, therefore, jacks were set on the pedestals, taking a lift under the angles used to anchor-bolt the posts, and with the jacks carrying the load the I-beam webs were cut with torches.

The erection of the centering was begun March 11, and was completed ready for the arch rib forms on April 4. As the concreting of the arch ribs and struts was finished, as already stated, on May 3, it required a little less than $2\frac{1}{2}$ months to build the centers and the rib and strut forms and to place the concrete for ribs and struts. This is submitted by the engineers and the contractor as being remarkably fast progress. The bridge is being built by the city of Pittsburgh, Pa., John D. Stevenson, assistant chief engineer, in charge of bridges. Fred C. Coder was engineer in charge of construction. The contractor was The E. M. Wichert Co., Pittsburgh, Pa.

Railway Car-Icing Plant to Serve Refrigerator Trains

Standard Layout for Icing Trains While Changing Engines at Division Points—Ice Making, Storing and Handling

TYPICAL of standard plans for railway car-icing plants which have been adopted by the Pacific Fruit Express Co. is the plant at Ogden, Utah, a plan of which is shown in Fig. 1. These standard designs for track layout, buildings and equipment were prepared in connection with a program for establishing a number of new plants along the Southern Pacific Ry. and Union Pacific Ry., since the time and cost of construction will thus be reduced materially. In the Ogden plant a one-story building 100 x 150 ft. contains the compressor room and ice-making or freezing room. Adjacent to this is a two-story building 85 x 165 ft., with the first floor holding ice for the day's work and an upper room for storage. Beyond this is an ice house 150 x 165 ft., divided into two sections of 10,000 tons capacity each for general storage and winter storage.

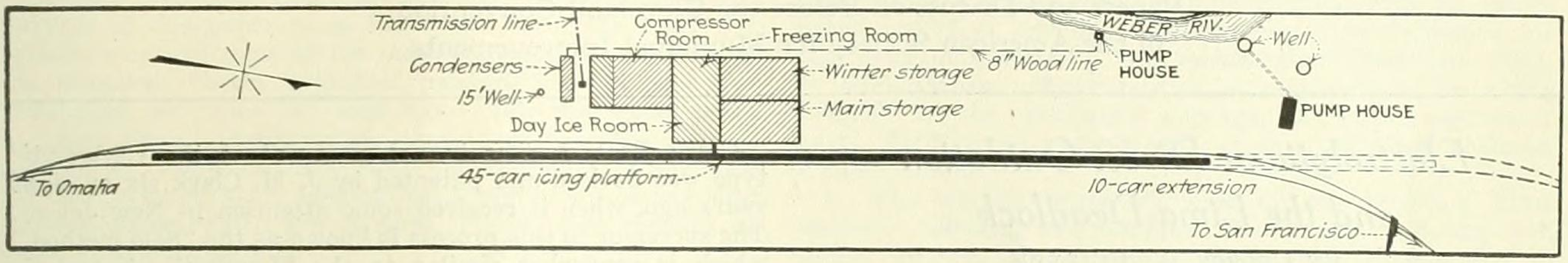


FIG. 1. CAR ICING PLANT AT OGDEN, UTAH

Ice blocks on the first floor of the day storage building are trucked to an inclined conveyor which carries them to the upper end of an inclined chute extending to the roof of the icing platform, as shown in Fig. 2. This chute connects with a similar but steeper chute at right angles to it, which in turn delivers the blocks to a conveyor running along the center of the icing platform. Men with ice tongs pull the blocks off the conveyor and slide them over hinged aprons to the hatches of the car bunkers. Two tracks long enough for solid trains of 45 cars are served by this elevated platform and provision is made for increasing this length to take 55-car trains.

Reinforced concrete is used for the buildings, which have sides of pilaster and curtain-wall construction and floors of the flat-slab type on girders between columns

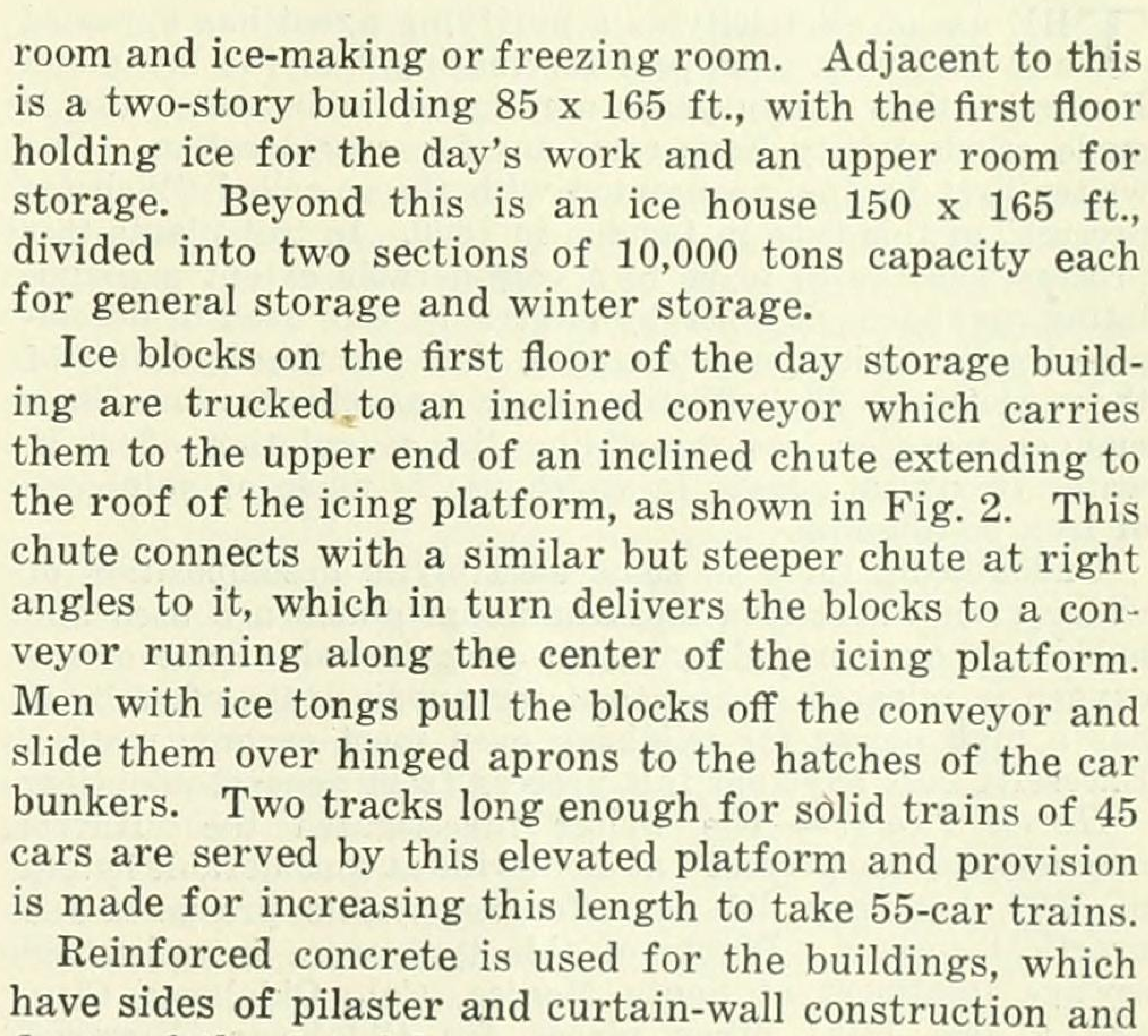


FIG. 2. ICE ROOM AND ICING PLATFORM